 274-79

10 January 1979

MEMORANDUM FOR: Deputy Director, National Foreign Assessment Center

SUBJECT: Request to Speak Before a University Audience

I request approval to present a lecture on "An Overview of Nuclear Energy Intelligence" to the Nuclear Engineering Department of North Carolina State University on 15 February 1979 at 1600 hours. This lecture will be part of a long standing series which has brought a variety of speakers in the nuclear energy field to N. C. State. It is being given at the request of Dr. T. S. Elleman, head of the department, and Dr. R. P. Gardner, chairman of the lecture series. The total cost of this trip to the government will be an estimated $125. The honorarium mentioned in the attached invitation will be declined.

STATINTL

[redacted]

OSI/Nuclear Energy Division

Attachments:
1. Text of the Speech
2. Letter of Invitation

I have reviewed this speech and found it to be unclassified.

STATINTL

[redacted]

Chief, Nuclear Energy Division/SI

10 JAN 1979

Date

SUBJECT: Request to Speak Before a University Audience

CONCUR:

STATINTL [redacted]

11 JAN 1979

Director of Scientific Intelligence — Date

STATINTL [redacted]

for D[redacted]

1/16/79

Date

[redacted]

16 JAN 1979

STATINTL for Coordinator for Academic Relations — Date

APPROVED:

[redacted]

17 JAN 1979

Deputy Director, NFAC — Date

STATINTL

Approved For Release 2005/01/10 : CIA-RDP86B00985R000400060056-2

NORTH CAROLINA STATE UNIVERSITY AT RALEIGH

SCHOOL OF ENGINEERING

DEPARTMENT OF NUCLEAR ENGINEERING
BOX 5636 ZIP 27650

November 28, 1978

[redacted]

Dear [redacted]

As per our telephone conversation of today, I am pleased to formally invite you to give us a Colloquium on February 15, 1979. The proposed title "Overview of Nuclear Energy Intelligence" sounds fine, and we look forward to hearing about some of the things you have been doing since you left here.

Our normal policy is to give speakers an honorarium which covers expenses in the event that their employer does not want to sponsor the trip. We can offer you an honorarium of $100 in this event.

Please let me know if this will be alright. We look forward to seeing you in February.

Yours truly,

Robin P. Gardner

Robin P. Gardner
Professor

RPG/ss

I left here in June of 1975 with my freshly minted Ph.D. in Nuclear Engineering. Rather than working on tritium diffusion under Drs. Elleman and Verghese, which was quite the rage when I was here, or on any of the lab-related problems of the rest of the faculty, I chose the rather esoteric route of doing neutron transport theory under Dr. Siewert. That was interesting, even fun sometimes, but not calculated to have the giants of industry beating down my door to give me a job, particularly when you remember that in the spring of 1975 utilities were cancelling reactor orders right and left. Fortunately for me, at this time the CIA was looking for a Ph.D. type in nuclear engineering, and since they were going to have to teach whomever they hired the basic things they wanted him to know, nuclear weapon design and intelligence analysis, I fit their requirements quite nicely. Now, due in part to our new policy of greater openness and in part to the kind invitation of Drs. Elleman and Gardner, I am making a return appearance to my alma mater, only on a different side of the lectern.

So, what is a scientist like me doing in a house full of spys? Quite a lot, really, and while I'm not in a laboratory examining spent fuel elements trying to work around the problems of densification--or have they solved that since I left--I would say that my talents are being well utilized.

The mission of the CIA is spelled out by Executive Order to include:

a. the collection of foreign intelligence, including information not otherwise obtainable, and to develop, conduct, or provide support for technical and other programs which collect national foreign intelligence, and

b. Produce and disseminate foreign intelligence relating to the national security, including foreign political, economic, scientific, technical, military, geographic, and sociological intelligence to meet the needs of the President, the National Security Council, and other elements of the United States Government.

In short, collecting information and figuring out what it means.

The second part, figuring out just what the information that has been collected means to the problems of interest to US policymakers, is the function of a portion of the CIA known as the National Foreign Assessment Center, or NFAC. Far from being "spys" the employees of NFAC, of which I am one, are generally engineers and biological, physical, or social scientists with a breadth of disciplines, experiences and specialities which would rival those of a good sized university faculty. Eleven percent hold a doctorate degree and 54% hold at least a masters degree. There is also a multidisciplinary emphasis with 25% having done graduate work in more than one discipline with a similar percentage holding degrees in more than one discipline. The most widely held degrees are in history, economics, political science, international affairs, foreign languages and area studies, geography, engineering, and physics although architecture, medicine, law, and anthropology, as well as many other disciplines, are also represented. Roughly half of NFAC's employees have had experience in industry with significant percentages also having experience in universities and in other government agencies. Altogether, a rather varied and "nonnefarious" group of people.

That part of the analysis function which concerns scientific information is handled by the Office of Scientific Intelligence or OSI--and no our director's name is not Oscar Goldman and we don't have a $6 million dollar bionic employee named Steve Austin and I'm not sure what we would do with him if we did. Problems of interest to OSI include laser technology, particle beam weapons, advanced civil technology, chemical and biological warfare, and the entire range of nuclear energy related problems. Its employees are almost all physical and biological scientists and engineers with an impressive array of credentials. Almost 40% hold doctorate degrees and 68% hold at least a masters degree. Over 50% have industrial experience and over 50% have had teaching and/or research experience with a university. Most of us view ourselves as scientists first and intelligence analysts second, although it is not always clear such a distinction needs to be made.

Getting to the heart of my discussion, the mission of the Nuclear Energy Division or NED--you must forgive me for speaking in alphabet soup but it becomes so much second nature that saying the term out feels awkward--the mission of NED is the analysis of information concerning and the production of intelligence on any and all foreign programs involving nuclear energy. This includes both the military applications and the peaceful applications.

The analysis of a foreign country's ability to design and produce nuclear weapons as a threat to the US is the more historic part of that mission, dating back to when the big question was, "When will the Soviets get the bomb?" Now the relevant problems are considerably more complex:

a. How big are the warheads on the missiles of a potential adversary?

b. What are the reliabilities and vulnerabilities of these warheads?

c. How many warheads does a potential adversary have? What is their capability to make more?

d. What variety of warheads exists to meet different military requirements?

e. How might possible arms control treaties affect a foreign stockpile vis-a'-vis our own.

f. What is a country's potential for developing a radically different design that would represent a significantly new and different threat to US personnel and systems.

A variety of techniques and resources are brought to bare on these problems, not the least of which is US experience in the design and manufacturing of nuclear weapons. One of the more interesting techniques involves the analysis of the isotopic and chemical composition of the debris, or "fallout", from those nuclear tests conducted in the atmosphere. This analysis can be used to learn quite a lot about the materials and level of technology employed in the device being tested.

A function of growing importance--particularly with the policy emphasis of the current administration--is the monitoring of the technical aspects of the nuclear proliferation problem. This comprises in large part monitoring the several basic nuclear programs in countries around the world including such things as nuclear power, nuclear research, and the nuclear fuel cycle. Of course, the greatest emphasis is on the sensitive aspects of the nuclear fuel cycle including such things as uranium enrichment and spent fuel reprocessing. Developments in the high explosive industry, with their potential application to nuclear weapons, are also of interest.

The goal is to detect an incipient nuclear weapon program or activities which ultimately could lead to such a program or the option for one.

As with the weapon design function, a variety of sources of information are available, but they are of a somewhat different nature. A large part of the information comes from open sources--such as technical journals, newspapers, and other media--and from American contacts--official and unofficial--with foreigners. This information, however, is generally what a foreign country wants you to know. It is the smaller, harder to get fraction available from agents and technical collections which fills in the gaps and gives the answers to the hard questions.

The third major function of NED is to provide support to the verification of treaties. Currently the major treaties of interest are the Limited Test Ban Treaty--which bans nuclear testing in the atmosphere--the Threshold Test Ban Treaty and its companion Peaceful Nuclear Explosives Treaty--which bans nuclear explosions of greater than 150 kilotons and which is currently being observed pending ratification--and the Non-Proliferation Treaty--which is designed to facilitate the transfer of nuclear technology while banning the development of nuclear weapons by the non-nuclear weapon states. In addition, we are supplying extensive support to verification questions arising from negotiation of a Comprehensive Test Ban Treaty--which will ban nuclear weapon tests for a specified period of time--and some support to SALT-related questions. Treaty monitoring is accomplished by a number of technical systems known jointly as "national technical means". The President has recently announced that this includes photo-reconnaissance satellites.

Now that I have discussed what it is we do, let me spend some time on how we do it. For some fairly obvious reasons I cannot be too specific and give you very many examples. Still, there are some general principles of intelligence analysis which are of interest.

Basically, scientific intelligence involves determining the technical capability of the party of interest to carry out any of a number of potentially significant actions. It does not deal with his intent to do so. For example, scientific intelligence would deal with whether or not the new Soviet ICBMs have the accuracy and yield to consititute a threat to Minuteman. It does not deal with whether, given the capability, the Soviets intend to use them in a counterforce first strike. Of course in many cases, an understanding of the intent of a party does have a bearing on whether a scientific potential is or has been developed into a technical reality.

There is one important tool which we have which separates scientific intelligence from economic or political intelligence. We have the laws of nature, particularly chemistry and physics. These effectively restrict what can and cannot be done. They also lead to the identification of physical observables of the activities of interest. For example, if a country desires to make plutonium to build an atomic bomb they need a reactor. Furthermore, the reactor will produce heat which must be discharged and which is hard to hide. Locating the heat source locates the reactor, measuring the quantity of heat discharged leads to a measure, depending upon assumptions about the reactor design, of the amount of plutonium being produced.

On the other hand, we must be very careful not to confuse things which cannot be done with things which we haven't figured out how to do yet. This is not trivial. During the early 30's the eminent scientists all thought they were producing transuranics by bombarding uranium with neutrons. The fact that they might be splitting atoms didn't occur to them until later in the decade. Yet in 1945 the fission process was used to produce the largest man-made explosion seen to that date. A country's intelligence process which was governed by the state of knowledge of the early 30's would have held an atomic bomb to be a violation of the laws of nature. If that country were threatened with one, they very likely would not have taken the threat seriously, much to their detriment. Witness Japan.

Actually, we at the CIA carry out our work in much the same way that you do in university research. The first job is always to define the problem. We have certain guideline questions which are felt by the US policymakers to be very important to our security. Within these guidelines, however, we often have freedom to investigate particular problems which we feel might be important or which might make a contribution to answering a policymaker's questions.

Once the problem is defined, we try to identify what it is that we need to solve it. Is the information available in the open literature? What are the observables involved? Does the technology exist to collect those observables? Do we need to task resources for agent collection? Is the information we are trying to collect important enough to justify the risks and costs of collection or can the analysis be done without it?

Once these questions are answered, a collection strategy is defined, that is we try to design the proper "experiment" to make the necessary measurements or to develop the necessary agent access.

Finally, the data is collected. Sometimes this can be done in a matter of hours or days, sometimes months or years--just like Ph.D. experiments except that staff salaries are rather more lucrative than research assistantships so we can afford to be a little more patient if necessary. Of course, if the President wants the answer tomorrow, you can't go out and design a collection system which will give you the data in 1984.

Once the data is collected, you have to figure out what it tells you. You sit down and think about the problem, again in a manner similar to a research thesis. In the long run, being a good intelligence analyst requires that you be an imaginative individual with a minimum of preconceived notions about the way things ought to be. These are qualities which are characteristic of a good scientist.

This is the way things are supposed to work. Sometimes they work that way. Often they are somewhat different, and they are rarely that well defined.

One major difference arises from the fact that the problems themselves tend to be dynamic rather than static. Their nature is constantly changing and evolving with most current problems having a history of past interest. The state of Chinese nuclear weapon design changes each time they have a test. A country's nuclear power program reflects a variety of changing political, economic, technical, and environmental factors. As a result, our analysis process must be dynamic with collection strategies constantly being reviewed to reflect changing priorities and opportunities. It also means that rather than defining a new problem that has not been worked on, we are often picking up older problems that have been evolving and for which there is already a body of collected data, which may or may not be relevant, and continuing to work on it until something happens that is worth reporting.

Another difference arises from the required timeliness of responses to support the policymaking process. You simply don't always have the time to investigate a matter thoroughly. You take the data which is on hand--on hand because the question of the moment is part of some evolving overall question, find out what additional information you can quickly add and do the best you can to provide the response.

Still another difference in the way we work arises from the fact that data collection systems are very expensive and must be designed with long lead times and a multitude of missions. Also, you don't usually get the foreign lab director as a source of information, you're much more likely to get the janitor. Thus your "experiments" are rarely optimized to collect your data. This does have an advantage though, because the universality of the collection system cuts down the lead time necessary between planning and data collection. It also facilitates collection against our evolving questions where an optimum strategy today might not be optimum tomorrow. Finally, it lets us collect background data against a problem which might not be of high interest today but which might be later. This makes our quick-response actions easier.

Finally, you have to recognize that you are not in control of the process you are collecting against. You can't keep it going until you get all the data you want, and if you miss it, well you can't go tell the Chinese to retest that nuclear device--our debris collection didn't work. Its gone and you do without it.

As a result of all of this, you never really have enough data. We do a lot more extrapolating than we would like. That engineering "feel" for what is happening becomes as important as the scientific proof. An analyst who waits until he has all the facts required for rigid scientific proof that he is right will usually find that either he will never know enough to say anything useful or he is a couple of years late with his answers. You do the best you can with the data you have and assign a confidence to the answer. Of course you will be wrong occasionally, sometimes more than occasionally! We know that, and accept it as part of the risk necessary for the production of timely information. The acceptance and value of that risk, however, is something that is often misunderstood by many.

In a lot of cases, you never know if you were right or wrong. The only way we will ever know how accurately we have estimated the yield of a particular Soviet warhead is if they launched it at us, in which case we won't be around to be second guessed.

There is one additional difference between the way we work and the way you work in university research. That is a question of breadth versus depth. Scientific intelligence is not designed to push the frontiers of technology, it is designed to understand that the frontiers are being pushed and what the implications are for national security. For example, we do not get involved in the technical problems of a CIVEX process, but would be very interested in determining whether a proposed process really was proliferation resistant. The intelligence analyst must develop the ability to understand a broad range of technologies and to handle a variety of questions. Sometimes we find ourselves explaining these technologies and publishing survey articles, some of which I have brought for you to take a look at, which will help the policymakers understand the technologies and the implications of advances. These articles are certainly not appropriate to a scientific journal, however. Still, the technical background, and often industrial experience required to understand and speak knowledgably about these technologies is not inconsiderable.

There are occasions when the question at hand does require that leading edge of technology. In those cases, we supplement our capabilities with external analysis. The question at hand may be the development of the hardware to collect the data we desire for analysis in a manner consistent with operational constraints. It is a fairly simple matter to measure the heat output of that plutonium production reactor I mentioned earlier if you can put a thermometer and flowmeter in the inlet and outlet pipes. It is a whole different ball game if you can't get near the plant. A different problem arises when the data we have obtained requires sophisticated laboratory analysis before it is in a usable form. This is the situation for the debris from a nuclear test. In fact, sometimes we require the development of new data anlaysis techniques in order to use substandard data or in order to milk the last possible bit of information from our collections. In addition to data anlsysis problems, some particularly tricky questions involving development of new technologies require that we seek external support to understand them.

External support can take a number of forms. For hardware development, it is supplied by other branches of CIA and their contractors. We provide both with a great deal of guidance on what it is we want and on whether what they can give us can do the job. On the data analysis and technology questions, we are able to consult some of the top scientists in the nuclear field in order to bring a wide variety of backgrounds and experiences to bear on our problems. Our working relationships with national laboratories are of particular value. It is important to be able to guide these consultants and meld the results with the variety of other resources available.

I believe that you will find one of the data analysis techniques which has been developed under our sponsorship to be interesting--actually, I shouldn't say developed because work is still going on. It is aimed at the analysis of very low count gamma spectral data. In those problems where we are interested in obtaining gamma spectral data for element identification we would design into our collection system a multichannel analyzer. We would normally hope to collect several thousand counts which, in an MCA with several tens of channels, should be sufficient for element identification. In the laboratory, you would collect data until you got the number of signal counts you want. We don't have that luxury and we might end up with data with only a few hundred counts and a signal-to-noise ratio of 1-to-2 or worse. The first inclination is to say that we detected a radioactive source, but can't say what it is. That answer just isn't good enough in most cases. It is for these low count spectra, where just looking at the data doesn't give you an element identification, that the technique of pattern recognition is useful.

In general, pattern recognition involves comparing the experimental spectrum with a set of reference spectra which have been normalized to a similar number of counts. The channel by channel variation--in standard deviations--of the experimental spectrum from each reference spectrum is calculated and summed. A source identification is then assigned to the experimental spectrum based on the lowest total deviation.

There is one obvious drawback to pattern recognition. The set of reference spectra must include the source which actually created the experimental spectrum in order for there to be any chance of correct identification. In most practical cases we cannot be sure of this inclusion. We usually do, however, have information which serves to limit the sources we would usually expect to see. Where candidate sources are indicated, this technique supplies the most rigorous method possible for picking the best candidate.

Just how well does this pattern recognition technique do in classifying sources? Obviously, given five reference sources a monkey will be right in his identification twenty percent of the time, so if the technique is to be of any value it must be right considerably more often than that. In fact, simulations have indicated that it is. Of course, we aren't trying to discriminate between tin-113 with its 393 KeV gamma from indium-113m and iodine-131 with its 365 KeV gamma. But given a group of elements such as cobalt-60, cesium-137, radium-226, selenium-75 and thorium-232, we can correctly identify a source greater than seventy percent of the time, the accuracy being much better for some isotopes than for others, with only 200 excess counts over a background of about 550 counts. The simulation was carried out by using a Monte Carlo generator to statistically create 150 spectra of the required number of background and source counts from each reference spectrum. These spectra were then classified according to the pattern recognition technique. The percentage of proper classifications was noted as well as the frequency with which the technique made each wrong answer. This sort of simulation presents a measure of our confidence in the proper classification of an experimental source.

Who is it we do all this for? Who is this vague and nebulous "policymaker" I have been referring to? Or, to put it more bluntly, "Who cares?!"

Well, to begin with, the President. By law, the Director of Central Intelligence acts as the primary adviser to the President and the National Security Council on national foreign intelligence. An important part of our job is to provide the briefings that the Director will use. The frequency with which you might be called on to do so, of course, varies with your area of responsibility but I will point out that our current President considers himself to be an engineer and enjoys technical items.

More frequently, we are called on to brief and provide papers for the National Security Council staff and other Executive Branch individuals providing policy advice to the President. Recently, we have been providing an increasing number of briefings to members of Congress and their staffs.

These briefings, at least for most members of NED, are more the exception than the rule. We don't usually see these customers face-to-face. Our written reports, however, do. We spend most of our time working on these reports which range from a few lines on a late breaking item to fifty-plus page intelligence assessments on a country's nuclear weapons program. We also make contributions to a number of interagency studies where CIA opinion is one of several melded into national intelligence assessments.

At this point, let me emphasize one thing. We provide factual information to policymakers. We do not provide policy advice. That isn't our job. We are hired to present unbiased information and assessments on what has happened and what foreign governments will do or are capable of doing. The policymaker is elected, or directly appointed by an elected official, to decide what constitutes the national interest and how to use the information we have provided to further that interest. I should mention that the impartiality of CIA analysis is widely acknowledged within the government, and the scientific and technical intelligence we provide is highly regarded.

So, now that I have discussed what we do and how we do it, the question arises, "What sort of training is involved in becoming an analyst in the Nuclear Energy Division?" Well, you start with an academic background, generally in nuclear engineering or physics although additional related majors are represented--much as on the department faculty here at State. A little better than a quarter of the division personnel hold doctorates with a similar percentage in addition holding masters degrees. About one third of the division has relevant industrial or military experience. This training and experience provides the basic "language of the science" and good background for the analysis of nuclear power programs.

On the other hand, despite the recent experiences at MIT and Princeton, nuclear weapons design is not something normally taught in the universities. As a result, one of the first tasks facing a newly hired weapons analyst is to become familiar with weapon design. Fortunately an old friend comes to the rescue. In addition to "Nuclear Reactor Engineering", which he wrote with Sesonske, and texts on reactor theory which he authored with Edlund and Bell, Samuel Glasstone has collaborated in writing the basic text on nuclear weapon design, as well as the major unclassified text on the effects of nuclear weapons. These provide an excellent background for further study.

One of the most useful tools we have in both our training and subsequently in doing our analysis is a summary of US weapons design activity over the last 33 years. This includes the ideas that worked, the ideas that didn't, and the design avenues which were abandoned for some reason before their feasibility was completely determined. This last group is often the most interesting when trying to analyze the activities of another country. Other countries have different military requirements and different resource constraints. As a result they are likely to adopt somewhat different lines of design from those taken by the US.

In addition to "book learning," new analyst training usually includes some facility orientation tours to US nuclear complexes. In these facilities you get a feel for what is required to design, manufacture, test, store, and handle nuclear weapons as well as exposure to the different components of the fuel cycle. I have had tours of Rocky Flats plutonium fabrication facility and the Bendix nonnuclear components production plant, as well as visits to US design labs at Los Alamos, Livermore, and Sandia Corporation and the weapons effects testing facilities at the Air Force Weapons Lab. Other analysts have had tours of the Monzano nuclear weapon storage site, the

Pantex weapons assembly facility, the Nevada nuclear test site, the plutonium production complexes at Savannah River and Hanford, the Oak Ridge and Portsmouth uranium enrichment facilities, and the chemical separation plant at Barnwell. Such trips have the added advantage of acquainting you with people whose advice can be sought if you have a particular problem which requires outside expertise.

Along with the informal training experiences, I have just described, more formal training is both available and encouraged. A number of courses are designed, for different stages of your career, to provide a broad overview of how the intelligence community supports the decisionmaking process and how other components of it work. Such an overview is vital to helping you establish the contracts and perspective necessary for the large portion of your problems which are multidisciplinary. Also, special interest courses with the same purpose are offered. One I found particularly interesting was a seminar on "China After Mao" which involved China analysts with a variety of political, scientific and military specialities in a series of lecture/discussion sessions with a number of university and policymaking figures all aimed at examining how China was and would be affected by the passing of Mao.

For those analysts whose work centers around the military application of nuclear energy, several interesting courses are available. A nuclear weapons orientation examining the design, testing, storage, handling, command and control, targeting, and effects of nuclear weapons is offered by the Interservice Nuclear Weapons School. The Ballistic Missile Staff course, offered by SAC, provides an excellent overview of the technical and operational characteristics of US strategic ballistic missiles. Another course examined the factors involved in the evaluation of overall strategic force effectiveness.

In a more general area, courses are available in information science and statistical methods as well as a large number of foreign languages. For those who want to further their technical education, a number of universities in the Washington area offer courses for which you can obtain Agency sponsorship.

In closing I would say that being an intelligence analyst is a fascinating business. It isn't for everyone. If you are strongly motivated toward lab work or the detailed examination of a narrow topic then you wouldn't enjoy it. But if you like the broader view, if you want to involve yourself in a variety of projects, and if the idea of contributing to the national security "turns you on," then I would recommend nuclear energy intelligence as an interesting career.